Winter Reproduction in the Gastropod *Nassarius trivittatus*

BY

JAN A. PECHENIK

Graduate School of Oceanography, University of Rhode Island, Kingston, Rhode Island 02881

INTRODUCTION

The role of temperature in triggering reproductive activity in marine invertebrates has been widely discussed (see Kinne, 1970). There often seems to be a critical minimum temperature required to stimulate spawning. *Nassarius obsoletus*, for example, the common mud snail, completes gametogenesis 2-6 months prior to the onset of reproductive activity (Sastry, 1971; Scheltema, 1967) but deposition of egg capsules is apparently delayed until a critical temperature is reached (Sastry, 1971). Similarly, *N. trivittatus* has been reported to initiate breeding as temperatures rise in the late spring, when water temperatures are 8°-13°C (Scheltema and Scheltema, 1964). However, egg capsules of this species were deposited in a flowing sea water system in the laboratory through December. Since temperature requirements for spawning are generally correlated with temperature requirements for successful embryonic and larval development (Kinne, 1970; Thorson, 1950), the ability of *N. trivittatus* embryos to develop at winter sea water temperatures was examined in the laboratory.

Nassarius trivittatus has been reported on the east coast of the United States from S. Carolina to the Gulf of St. Lawrence, from shallow water and deep water out to the continental shelf (Scheltema & Scheltema, 1964). *Nassarius obsoletus*, the comparison species for this paper, is common in shallow water from Florida north to the Gulf of St. Lawrence (Scheltema, 1967).

MATERIALS and METHODS

Fifteen *Nassarius trivittatus* dredged in Buzzard's Bay, Massachusetts on October 8, 1973, were held in a sea water table, the bottom of which was covered with mud. Dead fish and pieces of quahogs (*Mercenaria mercenaria*) were occasionally provided as food. The water flowing through the table was pumped from Great Harbor, Woods Hole, Massachusetts, and was within 1°C of the actual field temperatures monitored by the Woods Hole Oceanographic Institution at sixteen feet depth in the harbor. Measurements on egg capsules deposited were made at 50X, and those on eggs and larvae were made at 100X.

Capsules were collected shortly after spawning by carefully removing them from the sides of the water table. Undamaged capsules were placed in perforated plastic petri dishes which were then suspended in the water table. The egg capsules of *N. trivittatus* have been described and figured by Scheltema & Scheltema (1964).

OBSERVATIONS

Nassarius trivittatus sporadically deposited egg capsules in large numbers, from late October until at least mid-December, at which time the water temperature was approximately 7°C. The embryos emerged from the capsules successfully at winter temperatures. Embryos in 4 capsules collected at 11.2°C and suspended in the water table required 27-28 days to hatch at ambient temperatures, which had dropped to 8.8°C at hatching. Ten capsules spawned on November 26 at 9.6°C released veliger larvae after 35-42 days, the last capsules hatching at 5.5°C. Finally, capsules deposited at 7.4°C on December 14 began emptying after 55 days, at a temperature of 3.3°C. Twenty-six capsules collected on December 11 and held in aerated jars of sea water at room temperature (about 21°C) hatched out veligers in 5-7 days, the same pre-hatching developmental period described for summer embryos of this species held at room temperature by Scheltema & Scheltema (1964).

Mean capsule height (±95% confidence limits) as measured from the base of the capsule to the upper edge of the escape zone was 2.0 mm (±0.1 mm), and mean capsule width was 1.3 mm (±0.14 mm) for the 14 capsules measured. Eleven capsules were cut open and found to contain an average of 109.5 embryos each (range=70-144 eggs/capsule), well within the range of values reported by Scheltema & Scheltema (1964). Mean egg diameter was 133 μm (107 eggs from 7 capsules), and larvae at hatching had a mean shell length of 256 μm, with a range of 222-291 μm (112 shells measured from 2 capsules). Size at hatching was larger than that determined by Scheltema & Scheltema (1964 and personal communication) who recorded a

mean shell length of 225 μm and a range of 195-255 μm for larvae from capsules deposited in the summer.

DISCUSSION

The egg capsules of *N. trivittatus* are morphologically very similar to those of *N. obsoletus* (SCHELTEMA, 1962; SCHELTEMA & SCHELTEMA, 1964). The egg size of *N. obsoletus* (166 μm; COSTELLO & HENLEY, 1971) is slightly greater than that of *N. trivittatus*, and the size at hatching differs correspondingly (about 275 μm for *N. obsoletus* veligers; SCHELTEMA, 1962). The two species initiate reproductive activity at similar temperatures, as discussed below, and both species have a pre-hatch development of about one week at room temperature. (SCHELTEMA & SCHELTEMA, 1964; SCHELTEMA, 1967). Temperature requirements for embryonic development differ markedly, however. Embryos of *N. obsoletus* do not develop below 11-13°C (SCHELTEMA, 1967). In contrast, embryonic development of *N. trivittatus* proceeds at temperatures at least as low as 3.3°C. The successful escape of *N. trivittatus* veligers from egg capsules at 3.3° indicates that hatching substance (PECHENIK, 1975) is produced by veligers at 3.3° and is functional at these low temperatures.

Nassarius obsoletus from Rhode Island initiates reproductive activity in the laboratory at about 10°C (PECHENIK, *et al.*, in press), one to several °C below the minimum temperature at which embryonic development proceeds noticeably (SCHELTEMA, 1967). SASTRY (1971) also recorded egg capsule deposition at 10°C by *N. obsoletus* collected from Beaufort, N. Carolina. Embryos deposited at this temperature in the field are probably exposed to higher temperatures during at least part of each tidal cycle due to intertidal placement of the egg capsules (SCHELTEMA, 1967), and water temperatures warm up quickly after egg capsule deposition commences. Capsule deposition is completed by late August in all populations, while water temperatures are still high (JENNER, 1956). The timing of reproductive activity in *N. obsoletus* is thus well attuned to embryonic temperature requirements and conditions in the intertidal zone. Similarly, the ability of its embryos to develop at low temperatures may be an important factor in allowing *N. trivittatus* to occur as far north and at the depths that it does. The ability of *N. trivittatus* larvae to feed and grow at winter temperatures remains to be examined.

Whether subtidal individuals of *N. trivittatus* continue to deposit egg capsules during the winter in the field is unknown, although egg capsule deposition in the fall was observed by SCHELTEMA & SCHELTEMA (1964) at Barnstable Harbor, Massachusetts. Not all *N. trivittatus* seem to breed at low temperatures; several hundred snails dredged from Buzzard's Bay in 10-15 m of water in mid-November failed to deposit any egg capsules when held at field temperatures during a three-week observation period, November 14-December 6.

SUMMARY

1. *Nassarius trivittatus*, previously reported to breed only in the spring and fall, is capable of producing egg capsules at least until mid-December, at a water temperature of 7.4°C.
2. *Nassarius trivittatus* embryos can develop at winter water temperatures and escape from their egg capsules at temperatures at least as low as 3.3°C. The reproductive physiology of *N. trivittatus* is thus well correlated with the geographical and depth ranges of this species.

Literature Cited

COSTELLO, DONALD P. & CATHERINE HENLEY
1971. Methods for obtaining and handling marine eggs and embryos. 2nd ed., xvii+247 pp. Mar. Biol. Lab., Woods Hole, Mass.

JENNER, CHARLES E.
1956. The timing of reproductive cessation in geographically separated populations of *Nassarius obsoletus*. Biol. Bull. (Woods Hole) 111: 292 (abstract)

KINNE, OTTO
1970. Temperature (invertebrate reproduction). *in*: Marine ecology, 1 (1): 487-501; 9 text figs.; 3 tables J. Wiley & Sons, Ltd., New York, N. Y.

PECHENIK, JAN A.
1975. The escape of veligers from the egg capsules of *Nassarius obsoletus* and *Nassarius trivittatus* (Gastropoda, Prosobranchia). Biol. Bull. (Woods Hole) 149: 580-589; 2 text figs.; 5 tables

PECHENIK, JAN A., D. MICHAEL JOHNS & DON C. MILLER
in press. Reproductive consequences of continuous exposure to low concentrations of No. 2 fuel oil: studies on *Nassarius obsoletus, Crepidula fornicata, Urosalpinx cinerea*, and *Cancer irroratus*. *in*: Symposium on the state of marine environmental research. Narragansett, R. I., Environm. Prot. Agency

SASTRY, AKELLA N.
1971. Effect of temperature on egg capsule deposition in the mud snail, *Nassarius obsoletus* (Say). The Veliger 13 (4): 339-341; 2 text figs. (1 April 1971)

SCHELTEMA, RUDOLF S.
1962. Pelagic larvae of New England intertidal gastropods. I: *Nassarius obsoletus* Say and *Nassarius vibex* Say. Trans. Amer. Microsc. Soc. 81: 1-11; 4 plts.; 2 tables
1967. The relationship of temperature to the larval development of *Nassarius obsoletus* (Gastropoda). Biol. Bull. (Woods Hole) 132: 253-265; 2 text figs.; 1 table

SCHELTEMA, RUDOLF S. & AMELIE H. SCHELTEMA
1964. Pelagic larvae of New England intertidal gastropods. III. *Nassarius trivittatus*. Hydrobiol. 25: 321-329; 2 text figs.; 2 plts.

THORSON, GUNNAR
1950. Reproductive and larval ecology of marine bottom invertebrates. Biol. Rev. 25 (1): 1-45; 6 figs. (January 1950)